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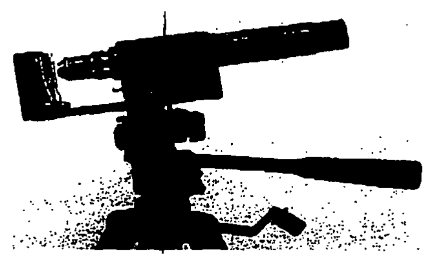
(54) MICROSCOPE DE TERRAIN
(54) FIELD MICROSCOPE

(57)
A novel series of field microscopes, which are designed for use in locations remote from conventional power sources or for in-lab use, are described. The enabling technology is the illuminator which is described in several ~ which cover brightfield transmitted light, brightfield reflected light, darkfield transmitted light and darkfield reflected light as well as uni-directional oblique and slit-ultra illumination techniques. The light sources are modular so that they can be interchanged on the micro cope, and they feature ultralow power and current consumption, integral dimming control, battery power and light weight. Optically the illuminators offer extremely flat field illumination along with excellent colour correction or selectable narrow wavelengths. a illuminators are characterised by high optical efficiency and small size. The microscope includes a novel focussing drive with torque limiting nature, a novel method of attaching the objectives, a novel mounting scheme to take advantage of existing camera tripods and novel adapters for film, video and digital cameras. A novel hydraulic fine focus drive is also discussed.



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(12) (19) (CA) **Demande-Application**

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(54) **MICROSCOPE DE TERRAIN**

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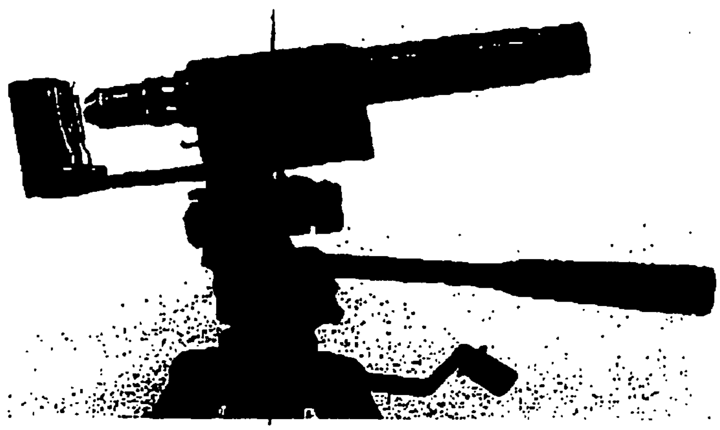

(57) A novel series of field microscopes, which are designed for use in locations remote from conventional power sources or for in-lab use, are described. The enabling technology is the illuminator which is described in several embodiments which cover brightfield transmitted light, brightfield reflected light, darkfield transmitted light and darkfield reflected light as well as uni-directional oblique and slit-ultra illumination techniques. The light sources are modular so that they can be interchanged on the micro cope, and they feature ultralow power and current consumption, integral dimming control, battery power and light weight. Optically the illuminators offer extremely flat field illumination along with excellent colour correction or selectable narrow wavelengths. a illuminators are characterised by high optical efficiency and small size. The microscope includes a novel focussing drive with torque limiting nature, a novel method of attaching the objectives, a novel mounting scheme to take advantage of existing camera tripods and novel adapters for film, video and digital cameras. A novel hydraulic fine focus drive is also discussed.

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ABSTRACT

A novel series of field microscopes, which are designed for use in locations remote from conventional power sources or for in-lab use, are described. The enabling technology is the illuminator which is described in several embodiments which cover brightfield transmitted light, brightfield reflected light, darkfield transmitted light and darkfield reflected light as well as uni-directional oblique and slit-ultra illumination techniques.

The light sources are modular so that they can be interchanged on the microscope, and they feature ultralow power and current consumption, integral dimming control, battery power and light weight. Optically the illuminators offer extremely flat field illumination along with excellent colour correction or selectable narrow wavelengths. The illuminators are characterised by high optical efficiency and small size.

The microscope includes a novel focussing drive with torque limiting nature, a novel method of attaching the objectives, a novel mounting scheme to take advantage of existing camera tripods and novel adapters for film, video and digital cameras. A novel hydraulic fine focus drive is also discussed.

FIELD OF THE INVENTION

The present invention relates to improvements to field microscopes.

DEFINITIONS

For the purpose of this patent application the following definitions apply throughout:

LED: LED is used to mean light emitting diode which may be either single colour such as red, green, blue, yellow, infrared or ultraviolet LEDs in any case type.

Laser diode: Any of the wide variety of semiconductor laser light emitting diodes including infrared, visible and ultraviolet laser diodes.

Diffuser: Any light diffusing material such as opal glass, sandblasted optical material, etched optical material, milky plastic or holographic diffuser material, but most particularly the family of white teflon materials and a proprietary material called Spectralon made by LABSPHERE.

Tripod Mount: A standard 1/4" x 20 TPI threaded hole designed to be compatible with camera tripod mounting screws.

A first embodiment of the present invention, shown in Figure 1 includes a stage module 100 which includes an LED 101 which may be a coloured LED or which may be a white light emitting LED which employs a system of several LED chips to achieve white light either internally to the LED encapsulation or as a set of discrete chips or die, or which may be a white light emitting LED where the white light is achieved by a phosphor coating on the LED die or on or in the LED plastic encapsulation so that the original substantial monochromatic light from the LED die is converted to broad spectral content white light. The LED emits light which strikes the diffuser 106 so that part of the light is transmitted by the diffuser 106 in the forward direction to the outlet of the illuminator 127 and part of the light is reflected by the diffuser and strikes the reflector optic surface of part 102 which serves a dual function to hold the LED in place and to reflect light back to the diffuser surface. Of the light transmitted by the diffuser a portion directly leaves the outlet of the illuminator 127 while light which is not within the acceptance angle of the output reflector 126 is reflected back to the front diffuser surface 106. This pair of mirrors acting on the front and back sides of the diffuser greatly increases the efficiency of the illuminator.

The cone of light from the diffuser can be tailored to any desired numerical aperture to match the maximum numerical aperture of the objective lenses used with the field microscope by the selection of the angles of the reflector surfaces of reflector 126 and by the diameter of the diffuser 106 and the illuminator outlet opening 127. The surface of the front reflector 126 may be a plane surface or a curved surface. The distance from the diffuser 106 to the LED 101 is determined by the cone angle of the light emitted by the LED and the diameter of the diffuser. The edge of illuminated circle

of the cone angle of the LED should match the clear aperture of the diameter of the diffuser. The angle of the rear reflector optic 102 should be chosen to maximize the return of reflected light to the diffuser and may be a plane surface or a curved surface.

A filter material 128 which may be an interference filter or a film or gel type filter may be used to remove unwanted light from the illuminator output. This is particularly true where the LED is a phosphor based white light emitting LED which uses a blue LED as the exciting source for the phosphor and where the blue LED emits UV light as part of its overall spectral output. In this case a material such as Lee Filter number 226 UV blocking gel is selected to remove the UV light from the LED output. The LED is powered from a printed circuit board 103 which contains the regulating and dimming electronics to control the LED brightness 105 and a control potentiometer 104 which is used to manually adjust the brightness of the LED.

The light from the illuminator passes through the glass slide 107 to illuminate the object 108 with a cone of flat light of spectral content determined by the choice of LED 101. The slide is held in place by stage clips 110 which are mounted to the front surface of stage block 109 by fasteners 111. The stage module 100 is connected to the rest of the microscope by a plug connector located at 112 which connects the stage module wiring to wiring buried in the base of the frame of the microscope 114. This allows the stage modules to be interchanged so that brightfield, darkfield, or other forms of stage can be used with the field microscope. The stage module is secured in position by fasteners (not shown). In the event that the microscope is used with reflected light systems as described below then the stage module 100 may be omitted entirely.

The frame of the microscope also contains a standard tripod mounting fitting 115 which is used to mount the microscope on any standard thread tripod such as a photographic tripod. The frame of the microscope is held in a dovetail slide at the main body end of the frame so that the frame forms the closure for the battery compartment containing the battery 118, the power on/off switch 116 and the external power connector 117. The dovetail slide also allows the movement of the body block 119 relative to the frame 114 in order to allow fine motion control. The battery 118 is in this case shown as a standard 9 volt transistor type battery. The external power connector 117 is used to supply power to the microscope when power is available such as from a solar cell array or from an AC wall adapter. Since the LED is so efficient it only requires typically 30 to 40 milliwatts of energy to achieve ideal illumination levels for the microscope. This means a typical 9 volt battery will last for 10 to 12 hours of continuous use and that a very small solar array can power the microscope for prolonged periods of time for applications such as third world and remote locations.

The body block 119 contains a bored hole for the microscope tube 120 which is driven for coarse positioning by shaft 130 which makes contact with body tube 119 via o-rings that convey the rotary action of shaft 130 to linear motion of tube 120. Tube 120 is contained in the bore with particularly chosen clearance so that no further bearings are required for the tube 120 and it can be freely driven by shaft 120. When the o-rings are chosen properly and the dimensions are properly calculated the tube will move freely but will resist motion due to gravity if the microscope is used in the horizontal position and yet will still exert sufficient force to move the tube with heavy objective against the force of gravity when the microscope is used vertically. The special feature of this coarse

motion drive is that it is torque limited which is important since with such a drive only a limited torque can be exerted on the object 108 or the slide 107 or a cover glass (not shown). This helps to prevent damage to the objective or the object or slide if the tube is driven into the slide by the coarse focus drive.

Normally an illuminator such as employed here would require a large diameter tube to counteract the effects of the stray light originating from the wide numerical aperture of the illuminator and the unrestricted field diameter of the illuminator. In this design the stray light is trapped and substantially eliminated by light traps in the tube. These light traps may be machined geometric structures or they may be simple materials with good light trapping or absorbing qualities. In this example the light traps are formed by black VELCRO type loop material which is placed inside the bore of the tube with the loop structure to the inside of the tube . Two traps are used one at the objective 122 end of the tube shown as trap 121 and a second trap at the eyepiece 125 end of the tube shown as light trap 124. A third light trap 123 is formed by a short length of black "pipe cleaner" which is placed in the form of a coil inside the barrel of the tube. These three light traps work to virtually eliminate any stray light from the objective from reaching the eyepiece and degrading the image contrast and clarity.

In figure two is shown a reflected light version of the field microscope. Here a transmitted light illuminator 200 is shown attached to the body tube. For this application a shorter body tube 120 is used in order to maintain the overall tube length to typically 160mm as is needed for 150mm objectives and eyepieces although other tube length components can be accommodated by chosing other tube lengths.

The transmitted light illuminator 200 employs an LED, typically a white light LED with phosphor conversion from blue to white light such as those provided by Chicago Miniature Lights or by MCD Electronics. The LED shines a beam of light through lense 203 which may be replaced by a fiber optic component as will be apparent to those skilled in the art. The light from the LED is reflected through 90 degrees by the cover slip beam splitter 209 which may also be a prism beam splitter so that the light is transmitted through the objective 122 to illuminate the object 108. For some applications such as examining large objects the modular stage 100 is removed by releasing the fasteners holding the modular stage and unplugging it from the frame. The light from the object passes through the objective 122 and the beam splitter 209 to the eyepiece 125. Since the eyepiece potentially looks at any stray light from the LED on the opposite internal wall of the tube 120 then a light trap is built in the opposing wall of the tube. The light trap consists of flat black mirror 205 which may be a black anodized aluminum material, or an absorbing material, and a secondary light trap surface of absorbing material 206, which in this case is the loop part of black VELCRO tape.

The power for the reflected light illuminator is supplied by wiring 206 from connector 208. Illuminator 200 may also contain a regulator and dimming circuit as described herein. The wiring to the LED is contained typically in a printed circuit board 204.

Figure three shows a general arrangement of the body 119 of the microscope and the frame 114 plate. The tube 120 is contained in the bore 129 which is typically 4/1000 of an inch larger than the diameter of the tube 120 prior to anodizing. For longer term use teflon, or linear bearings are used to mount the tube 120 in the bore 129. The o-rings

180 which may be rubber or any other suitable material such as viton or neoprene transmit the shaft 130 motion to the tube 120. All parts are typically anodized to prevent corrosion and to harden the surface against wear. The location of the tripod mount hole 115 is chosen so that it is substantially at the balance point of the microscope with standard tube, eyepiece and objective in the focussed position.

Figure four shows a detail of the coarse focus drive. The tube 120 is mounted in the bore 129 of the body 119. The coarse drive shaft 130 is contained in bore 192. The drive shaft is typically a brass shaft running in the anodized aluminum bore 192. There are no further bearings required for general use although for long term or professional use bearings are used to mount shaft 130 in bore 192 of body 119. The shaft is driven typically be two different dimension knobs. The small knob 190 fills the function of extreme coarse focus drive due its small diameter while the large knob 191 fills the medium coarse focus drive due to its larger diameter and consequent relative gear ratio compared to the shaft diameter. The rotary action of the shaft 130 is converted to the linear focussing action of the tube 120 by contact between the shaft and the tube via one or more o-rings 180. The diameter of the o-rings is chosen to give just the right degree of friction between the shaft 130 and the tube 120, which sets the drive torgue limit, and between the tube 120 and the bore 129 which sets the resistance to travel especially against gravity when the microscope is used in the vertical position.

The objectives in this microscope can be mounted using either the conventional screw mounting system such as the RMS thread or they can be mounted preferably using bayonet mounts such as the BNC connector bayonet design or any of the camera or other fitting mounts such as are well known to those skilled in the art. The use of bayonet

mounts for the objectives allows the rapid and trouble free changing of objective lenses. Alternately a rotary or linear action nosepiece can be used to bring one of a number of objectives into the optical axis.

Binocular eyepiece assemblies can also be used with this microscope by using a different tube design with a coupling to a binocular head assembly, not shown.

The field microscope can be connected to a standard C-mount video camera by arranging a tube 120 with a suitable length so that the primary image plane located 150mm from the objective mounting flange occurs at the CCD image plane. In this case the CCD will be overfilled and an aperture should be located upstream of the CCD to limit light outside the CCD image area from becoming stray light to the system.

A T-mount system can also be employed so allow the field microscope to adapt to standard film cameras. In this case a suitable tube is used to locate the film plane of the camera in the primary image plane.

A further adapter allows digital cameras to be mounted to the microscope. This adapter couples the digital camera to the microscope tube downstream of the eyepiece. The digital camera is then adjusted for focus at a distance typically 10 feet to match the image from the eyepiece.

In order to maintain the lowest possible current draw for this type of microscope it is important to use low current regulating circuits for the field microscope. Two particular low current driving circuits are included by reference and they are the LM317 series regulator circuit and the LP2951 series regulator circuit as described by National Semiconductor in their specification sheets, a copy of which are attached hereto as Appendix B.

A further discussion of this microscope is included in Appendix A.

TYPICAL ILLUSTRATIVE APPLICATIONS AREAS

The field microscope described herein is particularly suitable for use in remote locations for field research since it can be mounted on a tripod and therefore can accommodate virtually any terrain situation and at the same time be pleasant to operate for the user.

The low power consumption and this microscopes ability to be used in extreme climates make it ideal for rural lab uses in the third world for instance in malarial or bacterial disease testing in Africa. In this application a small solar array and rechargeable battery can be used to power the microscope indefinitely.

The microscope can also be used in extreme temperatures since all the sliding components are made of anodized aluminum and therefore all expand and contract in unison so that binding and unreliable operation will not result. There are no lubricants in the microscope and therefore no lubricants to thicken in cold weather use.

The rugged nature of this microscope coupled with its easy changeover from reflected to transmitted light make it ideal as a "scene of the crime" microscope for police agencies.

I claim:

1. A microscope with an LED illuminator where the LED illuminates a diffuser and the light from the diffuser is constrained by a reflective surface to a cone of suitable numerical aperture to illuminate the object.

2. A microscope as in claim 1 where the LED is a white light emitting LED employing a phosphor to convert the LED light to white light.

3. A microscope as in claim 1 where the LED is a white light emitting LED employing a frequency converting crystal to convert the LED light to shorter wavelength light.

4. A microscope as in claim 1 where the LED is a laser diode.

5. A microscope as in claim 1 where the LED is a plurality of various colored LEDs which together create substantially white light.

6. A microscope as in claim 1 where the LED is a plurality of various colored LEDs which can be individually controlled to create light of varying spectral content.

7. A microscope as in claim 1 where the LED is a white light emitting LED employing a blue or UV emitting LED to excite fluorescence in the object sample.

8. A microscope as in claims 1-7 which includes a modular stage containing the LED illumination means with connector to allow the stage to be quickly connected to the frame of the microscope and to be interchanged with other stages containing other illumination means.

9. A microscope as in claims 1-7 which includes a standard tripod mount consisting of a 1/4" x 20 TPI thread to allow the microscope to be used in the field with any standard tripod typically from photographic applications.

10. A microscope where the LED power consumption for illumination is less than 40 milliwatts.

11. A microscope where the LED power consumption for the illumination is less than 10 milliwatts.

12. A microscope which employs an LM317 series regulator as the dimmer control for the LED circuit.

13. A microscope which employs a low current regulator and variable current or voltage source as the supply for the LED.

14. A microscope where the power supply for the illuminator consists of a battery housed in the body of the microscope.

15. A microscope where there are light traps in the body tube which consist of VELCRO loop material.

16. A microscope where there are light traps in the body tube which consist of pipe cleaner material.

17. A microscope where there are light traps in the body tube which are calculated to overcome the normal stray light problems of fixed high numerical aperture and fixed illumination field diameter illuminators.

18. A microscope employing a tube drive mechanism which uses o-rings to convert rotary shaft motion to linear tube motion while at the same time setting a maximum torque limit for the drive.

19. A microscope where a bore in the anodized aluminum body forms the bearing for the tube of the microscope which is also formed of anodized aluminum material

so as to limit contraction and expansion problems during use in extreme environments.

FIGURE ONE

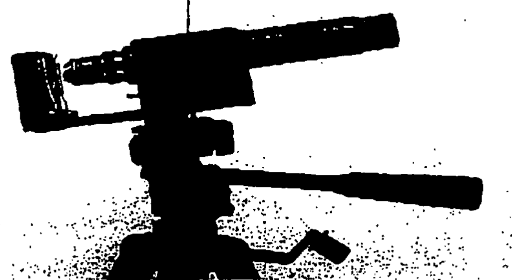


FIGURE TWO

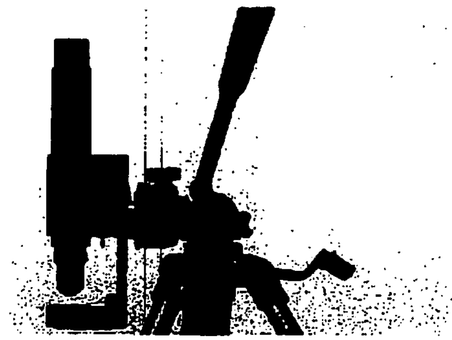


FIGURE THREE

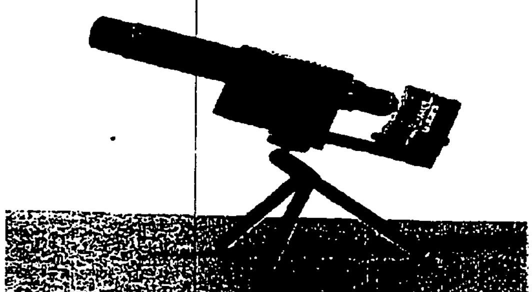


FIGURE ELEVEN.

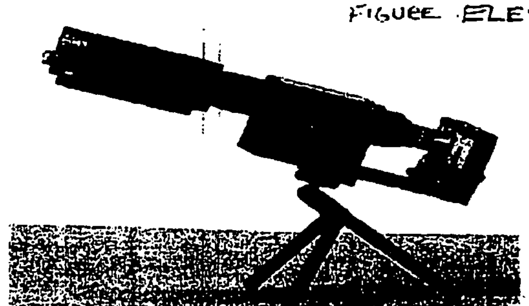
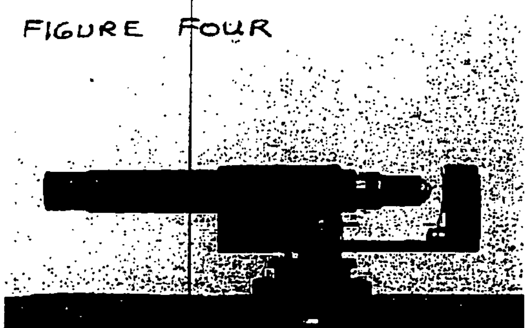
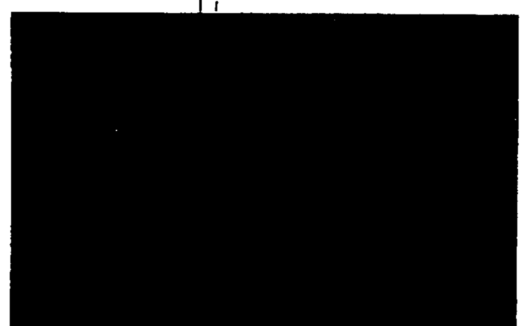


FIGURE FOUR





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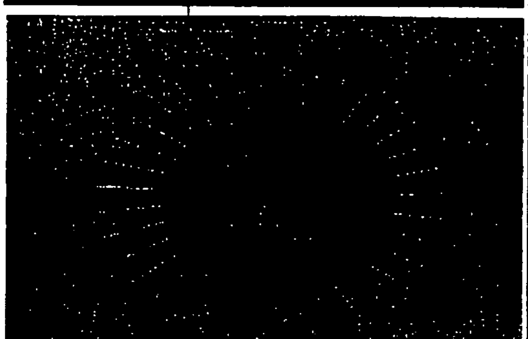

FIGURE SIX

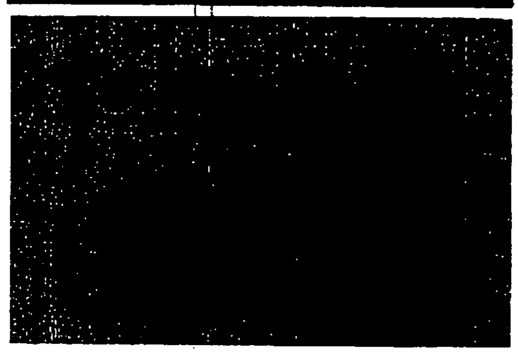

FIGURE SEVEN.

FIGURE EIGHT

FIGURE TEN

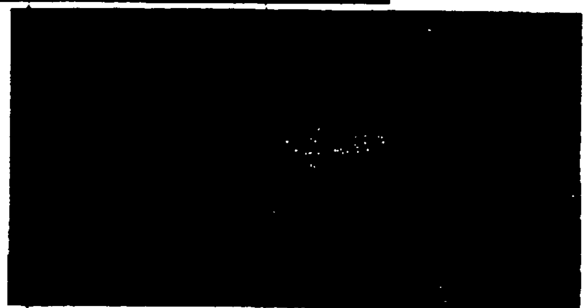

FIGURE NINE

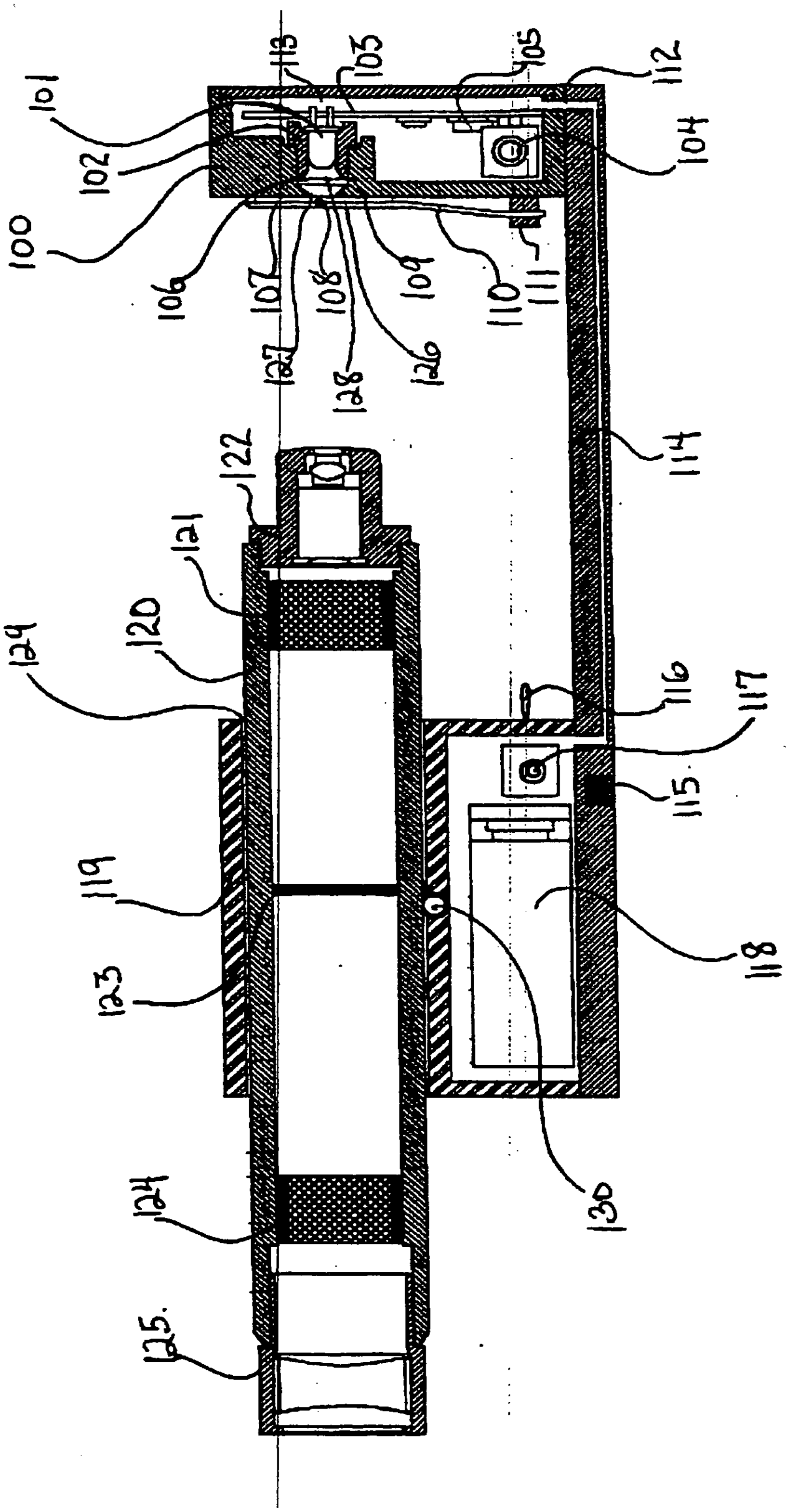
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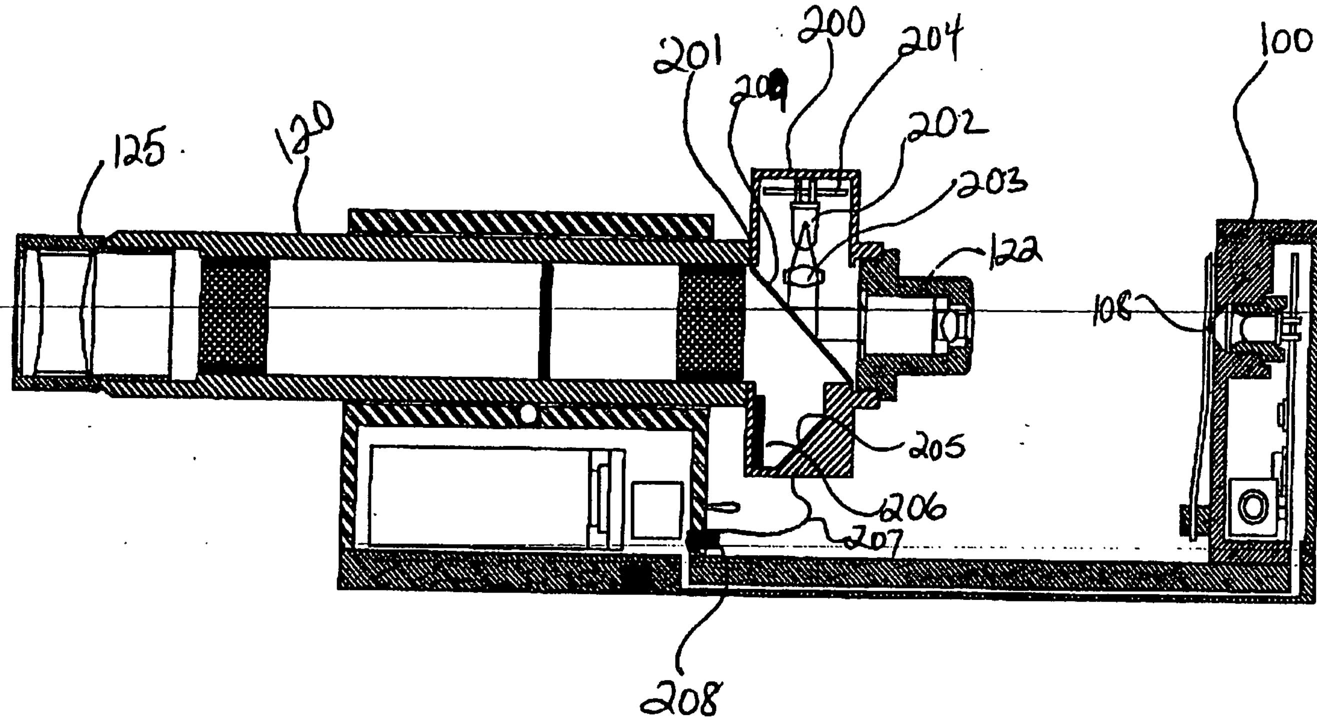
FIGURE ONE

FIGURE TWO



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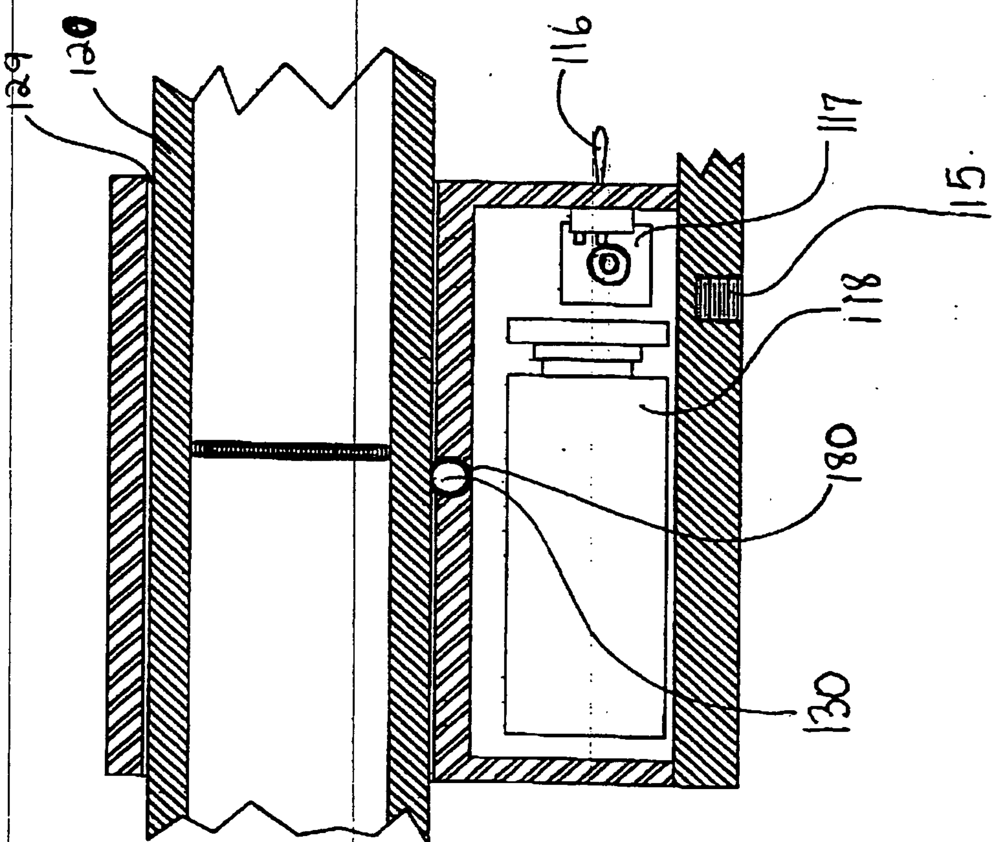

FIGURE FOUR